Relationships among Learning Styles and Motivation with Computer-Aided Instruction in an Agronomy Course

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ABSTRACT

Multi-media learning tools were developed to enhance student learning for an introductory agronomy course at Iowa State University. During fall 2002, the new interactive computer program, called Computer Interactive Multimedia Program for Learning Enhancement (CIMPLE) was incorporated into the teaching, learning, and assessment processes of the introductory course. At the end of the course, students completed (i) a Kolb's Learning Style Inventory, and (ii) a survey designed to record the students' use, satisfaction, and motivation to use CIMPLE. Learning outcomes were assessed using course grades. No statistically significant differences existed in CIMPLE use pattern among Kolb's five Learning Styles as students from each of these learning styles tended to use the seven components of CIMPLE about the same number of times. However, students who had a converging learning style tended to have the highest grades while students who were accommodators had the lowest grades. There was a significant positive correlation between student's motivation to use CIMPLE and the use of several components of CIMPLE, including chapter assessment, video, key concepts, practice, self-check, and environmental and ethical issues. Of the seven components of CIMPLE, only chapter assessment and environmental and ethical issues showed a significant correlation with student's final semester grades. This research is significant in demonstrating that computer-aided instruction can be designed to appeal to students across all learning styles. Further, this research demonstrates a connection between students' motivation to use instructional technology and the frequency of using the technology, and offers suggestions of ways to increase use and motivation of technology to improve learning outcomes.

THE USE OF COMPUTER TECHNOLOGY to assist students in the learning process is pervasive in higher education. While much attention has been placed on web-based instruction, the use of computer-based tutorial systems has also been shown to effectively help students learn in a natural resource–related course (Seiler et al., 2002). It is well known that students use different learning styles in their learning process (Kolb, 1981, 1984). It is not known whether students who prefer specific learning styles benefit, or are hindered, by computer-based learning systems. In addition to learning styles preferences, motivation has been associated with learning in computer-based learning environments (McWilliams, 2001). However, when using computer-based technology comprised of multiple components, it is unknown what role motivation plays with technology use or its relationship with students' learning outcomes.

In the studies presented in this paper, a computer-based, multi-media tutorial system was constructed for students in an introductory agronomy course at Iowa State University. Historically, the teachers of the course have used a combination of hands-on lab materials, video, live plants, greenhouse experiments, class discussions, and demonstrations to teach the subject matter. An interactive computer program, the Computer Interactive Multimedia Program for Learning Enhancement (CIMPLE), was developed to provide students computer-based learning programs to supplement students' lab experiences as listed above. The CIMPLE program is comprised of seven components (Table 1).

Research shows that the use of computer technology, coupled with face-to-face interaction with teachers, results in more student learning than face-to-face or computer-only instruction (Chadwick, 1999). CIMPLE was designed to increase student learning by providing a variety of avenues through which students could learn, in effect integrating the theory of learning styles in the design process of CIMPLE. Kolb's theory of learning styles asserts that students learn via two dimensions: the task dimension (bounded by doing and watching) and the emotional dimension (bounded by sensing/feeling and thinking). Using Kolb's Learning Style Inventory, it is possible to determine a person's preferred combination of task and emotional dimensions, resulting in five types of learning styles (Table 2).

While CIMPLE was designed with different styles of learners in mind, this report presents the first opportunity to test that design with students whose preferred learning styles are known. This leads to the following research questions (RQ):

RQ1. Are there differences in CIMPLE use among students from the different learning styles?
RQ2. Are there differences in course grades among students from the different learning styles?
RQ3. What is the relationship between the frequency in which students use individual CIMPLE components and student course grades?

The CIMPLE software was designed to be used in conjunction with classroom and text-based learning. Thus, teachers did not make CIMPLE use mandatory, in part or whole, for their students. To better understand students' CIMPLE usage, it was key to understand their motivations to use CIMPLE. Betty and Payne (1985) focused on *state* motivation as a means to measure the likelihood that a student will enact high levels of concentration and attention toward the completion of a task. Researchers pointed out that state motivation was more important to understanding than trait motivation, because the former is a manifestation of a student's needs while the latter is too general to accurately explain

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Abbreviations: CIMPLE, Computer Interactive Multimedia Program for Learning Enhancement; RQ, research question.

Table 1. Description of the components of the computer program called CIMPLE.

Component name	Description
Chapter assessment	Extensive true/false questions for students to assess their overall knowledge of chapter material
Video	20–30 minute digitized video that reviews chapter material and illustrates key concepts.
Key concepts	Educational material providing in-depth information on key topics of each subunit of a chapter
Practice	Interactive questions and diagrams for students to test their knowledge of key issues of each subunit of a chapter
Self-check	Short multiple choice quiz over subunit material
Practice problem solving	A practical problem is presented and students apply chapter material to solve the problem
Environmental and ethical issues	Students consider information on both sides of an environmental or ethical issue related to chapter material; students develop an argument for one side of the issue, write it up, and discuss their position in class

some course specific behavior (Christophel, 1990; Richmond, 1990). These concepts lead to the following research questions:

RQ4. What is the relationship between students' motivation to use CIMPLE and their frequency of using CIMPLE?

RQ5. What is the relationship between students' motivation to use CIMPLE and their course grades?

A second study was conducted to determine if using CIMPLE affected learning outcomes. The assumption behind this study was that once students learn how to use all of the available learning components to master course content, they will be able to do that on their own, in the short-term, with no adverse effect on their learning outcomes. Thus, if the use of the computer program, CIMPLE, is suspended for 2 weeks, will their grades be adversely affected? On a related note, students using CIMPLE then suspending their use of the tool may still demonstrate greater learning than those students who use CIMPLE intermittingly or not at all (i.e., students who use only one learning component, not all of the components supported through CIMPLE). The corresponding research question is:

RQ6. Over a 2-week period, what effect will suspending use of CIMPLE have on students' grades compared with students who use CIMPLE?

METHODOLOGY

Study 1

Research to investigate the first five research questions was conducted during fall semester 2002. One hundred four students (73%) of the 143 students enrolled in the introductory agronomy course (Agron 114) volunteered to participate in the study. Students were asked at the end of the semester if they would volunteer in an attempt to not cause an effect on student use of the CIMPLE program across the semester. Jordanov (2001) found that students' learning styles are stable across a semester's use of technology, thus presenting no validity risk by our determining students' learning styles at the end of the semester instead of at another time, or multiple times, in the semester. The volunteers were asked to complete Kolb's Learning Style Inventory, Beatty and Payne's student motivation scale, and allow the research team access to their course grades. The 104 students who participated in the study came from a variety of majors: 20 (19%) agronomy, 9 (9%) animal science, 24 (23%) agriculture studies, 27 (26%) agriculture business/education, and 25 (24%) other. Fifty-one (49%) students were freshmen, 27 (27%) were sophomores, and 26 (25%) were juniors or seniors. Sixty-four percent (n = 70) were farm reared with extensive field and farm-work experience, 17% (n = 18) were farm reared with little field and farm-work experience, and the remainder (n = 16) were not reared on a farm but had some field or farm-work experience.

Table 2. Description of Kolb's learning styles.

Learning style	Description
Accommodator	Prefer hands-on learning, benefiting from trial and error
Assimilator	Prefer concise and logical presentations of information, from which they can build accurate and organized conceptualizations
Balanced	Likely to use any of the styles, with no clear preference for any one learning style
Converger	Prefer practical problem solving exercises
Diverger	Prefer to be exposed to many points of view, listening, absorbing, and categorizing information from a variety of sources

Study 2

To address RQ6, all 143 students enrolled in Agron 114 during fall 2002 participated in the study. The same 104 volunteers who participated in Study 1 volunteered to not use the CIMPLE program during 1 of 2 weeks. The remaining 43 students agreed to serve as the control group, in which they were allowed to use CIMPLE freely throughout the 2-week period. During the 2-week period, 52 of those 104 students using CIMPLE were asked to not use CIMPLE during the first week but to use it during the second week, Group 1. The remaining 52 students, Group 2, were asked to use CIMPLE during the first week but not during the second week. Four of the original 104 students did not complete the study, and therefore were dropped from the results, leaving 51 students in Group 1 and 49 students in Group 2. Computer-based software tracking students' use of CIMPLE confirmed that the students either used or did not use the program as requested. All students permitted researchers to use their weekly quiz scores for those 2 weeks and their overall course grades in this study. The 2 weeks chosen for inclusion in the study were chosen because they were consecutive yet not cumulative in nature. Thus, performance in Week 2 was expected to be independent of performance on Week 1, because the content was not cumulative. The content of each week was similar in that 1 week was on insect identification and management and the following week on disease identification and management. The demographics of the students were the same as those in Study 1.

RESULTS

The first research question asked if there were differences in CIMPLE use by students from different learning styles. The results show that there was no statistical difference of CIMPLE use among the learning styles, as students from each of the five learning styles tended to use the seven components of CIMPLE about the same number of times.

Student grades were influenced by learning styles, ranging from a low average grade of 2.40 (where 4.00 is an A) for accommodators to a high of 3.24 for convergers (t (99) = 2.148, p = 0.033). The results showed that convergers and assimilators (3.06) were significantly higher than accommodators (t (99) = 5.406, p = 0.001).

Table 3. Average number of times students used individual components of CIMPLE correlated with student course grades.

Component name	Avg. no. of times used per student	Correlation to grades (n = 100)	Significance level
Chapter assessment	7.12	0.273	**
Video	8.18	–0.187	NS†
Key concepts	8.96	0.025	NS
Practice	10.21	0.050	NS
Self-check	9.99	0.018	NS
Practice problem solving	1.65	–0.004	NS
Environmental and ethical issues	2.32	0.232	*
Composite total	48.83	0.110	NS

* Statistical significance at $P < 0.05$.
** Statistical significance at $P < 0.01$.
† NS, no significant difference.

Of the seven CIMPLE components, video, key concepts, practice, and self-check were most frequently used (Table 3). There were significant positive correlations only between (i) grades and the use of chapter assessment and, (ii) between grades and the use of environmental and ethical issues.

As shown in Table 4, there was significant correlation between students' motivation to use CIMPLE and their use of each component and for the entire set of CIMPLE components.

Students' motivation to use CIMPLE showed a less consistent relationship to grades than to their use of CIMPLE. Table 5 shows that their motivation to use the chapter assessment and the environmental and ethical issues components are significantly, positively correlated with grades, but their motivation to use the video component was significantly and negatively correlated with grades. Post-hoc analysis, also in Table 5, show that only the use of the chapter assessment and environmental and ethical issues components are positively, significantly correlated with grades.

For Study 2, analysis of students' grades among the three groups showed no significant differences across the 2 weeks of study. Further, no significant differences in grades were found within any of the three groups across the 2 weeks. Analysis of students' course grades shows a significant difference across the three groups, F (2, 140) = 5.435, p = 0.005. Post-hoc Tukey tests showed no differences between the groups using CIMPLE during 1 of the 2 weeks, but both of those groups performed significantly higher than did the control group (the 49 students in the course who had unlimited access to use CIMPLE during the 2 weeks). The group using CIMPLE in Week 1 but not in Week 2 earned, on average, a 2.70 (2.67 is a B–) compared with the control group's 2.20 (2.33 is a C+) (p = 0.024). The group using CIMPLE in Week 2 but not in Week 1 earned, on average, a 2.78 compared with the control group's 2.20 (p = 0.006).

Table 4. Student motivation to use CIMPLE correlated with student use of CIMPLE components.

Component name	No.	Correlation of student motivation and student use	Significance level
Chapter assessment	98	0.499	**
Video	96	0.754	**
Key concepts	99	0.573	**
Practice	97	0.441	**
Self-check	97	0.462	**
Practice problem solving	97	0.293	**
Environmental and ethical issues	98	0.560	**
Composite total	90	0.280	**

** Statistical significance at $P < 0.01$.

Table 5. Student motivation to use CIMPLE and CIMPLE component use correlated with student grades.

Component name	No.	Motivation to use CIMPLE - grades	CIMPLE use - grades
Chapter assessment	98	*	*
Video	96	*	NS†
Key concepts	99	NS	NS
Practice	97	NS	NS
Self-check	97	NS	NS
Practice problem solving	97	NS	NS
Environmental and ethical issues	98	*	**
Composite total	90	NS	NS

* Statistical significance at $P < 0.05$.
** Statistical significance at $P < 0.01$.
† NS, no significant difference.

DISCUSSION

The finding that, for the most part, CIMPLE use did not significantly vary among learning styles is crucial to future learning-technology development and integration into courses. Students across the learning styles accessed the CIMPLE components in a similar manner, implying that the program was well designed for students representing all learning styles. This finding also produces evidence in apparent opposition to Buch and Bartley's (2002) finding that convergers show the largest preference for computer-aided instruction. However, we did find that convergers significantly outperformed accommodators. One possibility for this finding is that all students accessed the CIMPLE components similarly, but some students, accommodators in this case, did not find certain components as helpful as did other students. Tracking use data in terms of time would provide some insight into actual use that is not currently available. However, if certain components did not work well for one or more learning style students, we would expect that the usage rates for those components would drop as the semester went on. That was not the case.

Finding that chapter assessment use is positively correlated with course grades provides some evidence that that component is particularly useful in learning course content. Less clear is the reason why the environmental and ethical issues component showed a positive correlation with grades. We expect two phenomena may be occurring. First, students who desire to learn as much as they can, and engage all available resources, will likely perform better in any class. In contrast, students holding a narrowly defined view of agronomy (e.g., agronomy is about production not stewardship) may skip the ethical and environmental issues component, as well as other parts of the course not in line with their paradigm of agronomy. That skipping would likely cause a reduction in performance. Second, students engaging this component would provide themselves opportunities to link course content to additional constructs, helping build a more complete picture of that content, which may lead to better performance on exams.

The more motivated the students were to use the video component, the lower were their course grades. This may be because motivation to use chapter assessment signals a desire to recap learned information, helping to build a complete picture of that information. Motivation to use the video may signal a

preferred learning style of learning through visual input and if the student is not assessed through a visual means, then a disconnect may exist between information uptake and presentation (i.e., learning and the demonstration of that learning).

The observation that students who are motivated to use the CIMPLE program actually do use the program is not that surprising. Looking at individual components presents more interesting results. Though still significant, the difference in use of the practice and self-check components were the smallest (post-hoc analysis showed that highly motivated students used those components approximately 30% more often than did low-motivated students). The most striking differences occurred with environmental and ethical issues. Here, highly motivated students used the component 14 times more often than did low-motivated students. The differences might be explained by the nature of the components. The practice and self-check components contain questions and problems to solve that allow students to assess how well they know the chapter material in preparation for a quiz or exam. The environmental and ethical issues component is an exercise in which students are presented with both sides of an issue and are required to write a few paragraphs stating the side of the issue with which they most agree, and then be prepared to discuss their reasoning with other students in class. Additional motivation would be required to engage that component, as some students may believe the learning gained from the exercise may be irrelevant on course exams due to the perceived tangential relationship of ethics to course content.

The results from Study 2, the comparison of unit and course grades and using CIMPLE during a 2-week period, presented a mixed message. On one hand, no differences in grades across the users and nonusers of CIMPLE during a 2-week period may signal either that using CIMPLE did not matter, or that the content of the 2 weeks was such that using or not using CIMPLE provided no advantage. However, the findings from comparing course grades across Groups 1 and 2 and the control group provided more interesting results. Across the semester, students participating in the 2-week study, on average, earned nearly one-half letter grade higher than did students who volunteered as the control group and had unrestricted use of CIMPLE.

Future research should further investigate the ways in which students use the components of CIMPLE, or programs similar to CIMPLE. Although the program is designed for students to engage it in a component-by-component manner, they may well skip about from component to component depending on their learning styles or other factors. Additional research could investigate whether students use CIMPLE to generate an understanding of course content in preparation of an exam, or if they seek to understand exactly what will be on the exam, then work backward to find answers or ways to answer questions via CIMPLE. Evidence of the existence and efficacy of such "reverse learning" would be informative to computer-aided instruction designers.

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